PATENT SPECIFICATION

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Airfoil Construction and Method for Making the Same

We, KIRK-WING COMPANY, of Vega Baja, Puerto Rico, a Corporation organised and existing under the laws of Puerto Rico, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement :—

This invention relates to an airfoil construction such as an aircraft wing, and to a method for making it.

The manufacture and design of aircraft wings have always involved a number of compromises relating to weight, aerodynamic cleanliness, and expense of fabrication. These matters have had to be compromised, because the primary considerations which outweigh all others are the strength and configuration of the wing. Without adequate strength and the proper size and contour, the wing is not functional for its intended purpose. However, when building a wing of the proper size and shape with conventional techniques, it frequently is necessary to add weight, and joints at places where they are inherently undesirable, but which conventional techniques of design and assembly offer no way of avoiding.

For example, in a typical airfoil, front and rear spars provided which are joined together by ribs or formers and the skin is then riveted to the spars, ribs and formers. This raises the problem of how to achieve aerodynamic cleanliness on the surface. A conventional technique is to use countersunk rivets, but then the heads must be sunk into the skin. A sink can be provided either by dimpling the sheet adjacent of the rivet holes, or by countersinking the skin to form the holes. Dimpling requires an operation involving costs: it does not provide the cleanest surface, and it leaves a bump on the opposite side of the skin which has to be fitted into another dimple or countersink in adjacent structure. Thus, forming the dimple requires a dimpling operation in the skin itself and a countersinking operation beneath it. Such a fitting is inherently expensive and is often impossible or undesirable to use in many locations, particularly where the material removed from the adjacent structure involves a strength or fatigue disadvantage. When this technique is used, the head of the rivet is sometimes ground flush after being set. This reduces the inherent strength of the rivet, which is also an undesirable situation. On the other hand, if the skin itself is to be countersunk by removing material around the hole, then the skin at the rivet hole must be thick enough to provide hole length for the countersink and also for wall surface to provide adequate bearing surfaces for the rivet shank. As a practical matter, this dictates using a sheet thick enough at all locations to accommodate the rivet configuration, which thickness is greater than it has to be at all but the relatively few locations where the rivets are driven, thereby increasing the weight of the wing by a substantial amount.

Furthermore, conventional assembly techniques have required extensive provisions for access to the interior of the wing in order to complete its assembly. Access holes and plates add to the weight and complexity of a wing and its is desirable to use as few of them as possible.

It is an object of this invention to provide a wing which can readily be assembled with minimal provisions for access during assembly, which minimizes joints of more than two elements, which utilizes skin of maximum thickness only where such thickness is required, and a minimum thickness in other locations, and which is inherently

[Price 4s. 6d.]

Leading edge formers 31 include flanges 34, 35, which are adapted to be attached to the skin at the grids. Formers 31 have relief flanges 36, 37 at their forward and rear ends with lightening holes 38 in the middle.

Bulkheads are placed wherever it is desired to provide fluid-impermeable barriers. Leading edge formers are placed wherever else inside support for the skin is considered necessary.

In order to assemble the bulkheads and leading edge formers with the skin, they are placed inside the fold formed by the skin, and rivets 31*a* are driven to connect the leading edge of the skin and flanges 32, 34 and 35. These flanges may be predrilled to match holes in the skin. There is easy access for backing these rivets, because the skin can be peeled back as shown in Fig. 4 while the formers are riveted. The backing bar can readily be inserted in the fold of the skin between the formers and bulkheads. Access is available to both sides of the structure where the bulkheads are located. The flanges face outboard of the tank space defined between them. Therefore, no access holes are required for assembly of the tank section. Full lines of rivets and holes for rivets are not shown in the drawings, for the sake of clarity. It is evident that rivets are driven along all of the joints indicated herein, in accordance with common shop practice.

The next operation is the fastening in of a front spar 40 (Fig. 5). The spar includes a central shear web 41 and a pair of flanges 42, 43, which extend from the same side of the shear web, and form a U-shaped cross-section. The bulkheads are riveted to the spar by rivets passed through flanges 33, and through holes in the spar. The leading edge formers 31 are not attached to the spar.

Next, rivets 44 are driven to attach flanges 42 and 43 to the skin (Fig. 6).

The next step in the process is the attachment of the skin to trailing edge formers 45, which formers include central webs 46 and flanges 47, 48. The webs also include recessed portions 49, 50 at each end, and lightening holes 51. The skin is laid against flanges 47 and 48, and rivets 52 are driven to attach them. A backing bar can readily be passed through the opening between the edges 53, 54 of the skin.

The last step in the assembly process is the attachment of the rear spar, which accomplishes the closing of the wing. Rear spar 60 includes a shear web 61 and a pair of flanges 62, 63, which extend on opposite sides of the web to give the spar substantially a Z-shaped cross-section. Flange 62 is readily attached to the skin by rivets 64, at an edge which is entirely in the open for riveting operations. Flange 63 is enclosed, but rivets 65 are reached for backing by passing a backing bar 66 through the passage formed by recessed portions 50 and by shear web 61. The rivets are driven by a rivet gun 67, and are backed up by the backing bar. This completes the skin closure and the wing structure itself.

The resulting structure is shown in Fig. 8, where it will be seen that, because of the formation of the recesses, adequate thickness of integral material exists at the grid for the countersink head of the rivet plus sufficient hole wall for bearing of the rivet shank at the places where the rivets are attached. However, the thickness is reduced at the recesses to only that dimension which is required by strength considerations. It will be observed that no separate attachments are needed which might create a joint subject to excessive fatigue, for example. Instead, at every point, the skin is an integral structure, and the only joints are two member attachments by rivets, which are tight and fatigue resistant.

Furthermore, as can be seen from the aforesaid, the elimination of extra weight in the thickness of the skin plus the elimination of extra means of attachment and the minimizing of excess access holes, results in a wing of greatly improved properties and of minimum weight for its strength requirements.

Furthermore, forming the skin before removing the recess chemically, reduces the strains and wrinkling tendencies inherent in the usual means for attaching skin to formers and spars, and results in an aerodynamically clean optimum wing structure which is particularly well suited for light aircraft.

This invention is not to be limited by the embodiment shown in the drawings and described in the description which is given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

WHAT WE CLAIM IS :—

1. An airfoil structure having a forward and a lateral axis comprising, a skin having an airfoil contour, a grid of areas of a first thickness and a plurality of recesses in a surface thereof disposed within the grid where the skin is of lesser thickness, a front spar comprising a central shear web and a pair of integral flanges on the same side of the web; these flanges being directed rearwardly along said forward axis, a rear spar comprising a central shear web and a pair of integral flanges, one on each side of the web, said spars being spaced apart from each other along the forward axis, and being attached to the skin at portions of the said grid, a plurality of forwardly-extending leading

FIG. 1

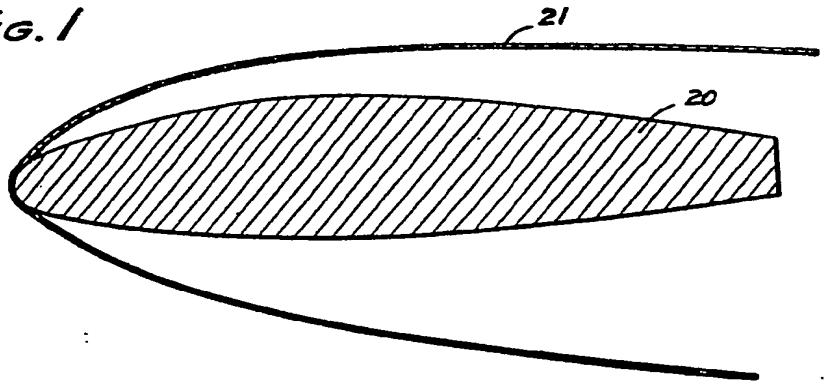
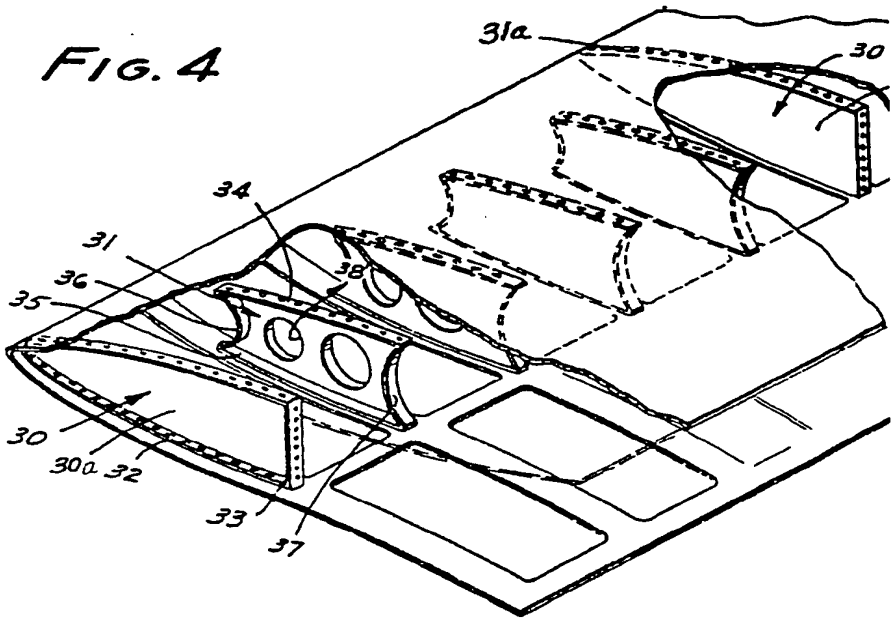


FIG. 4



1008671 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG. 1

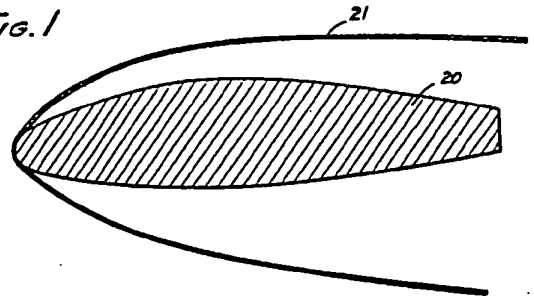


FIG. 3

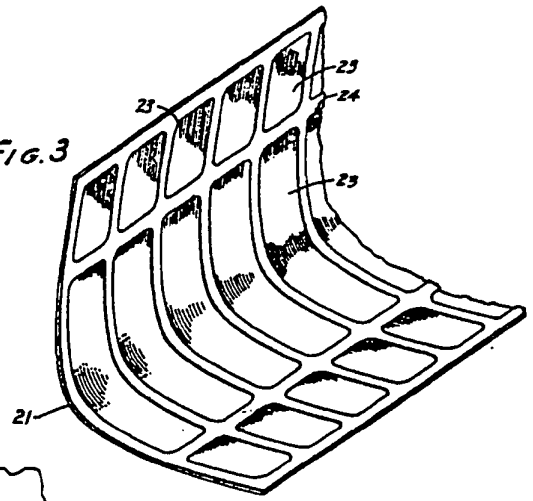


FIG. 4

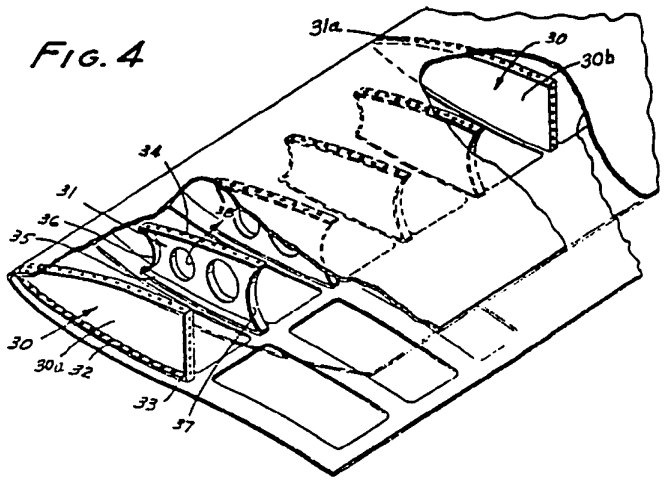
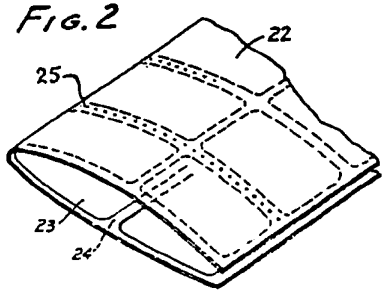


FIG. 2



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Sheet 2

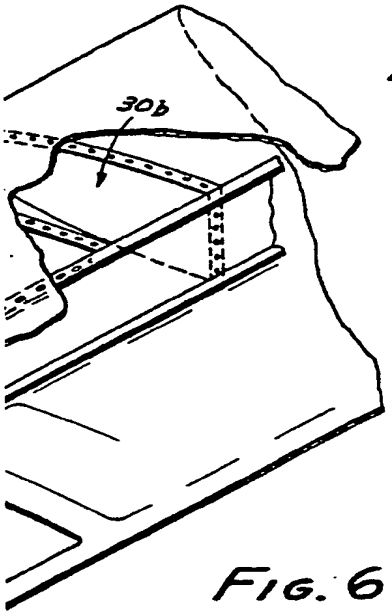

FIG. 8

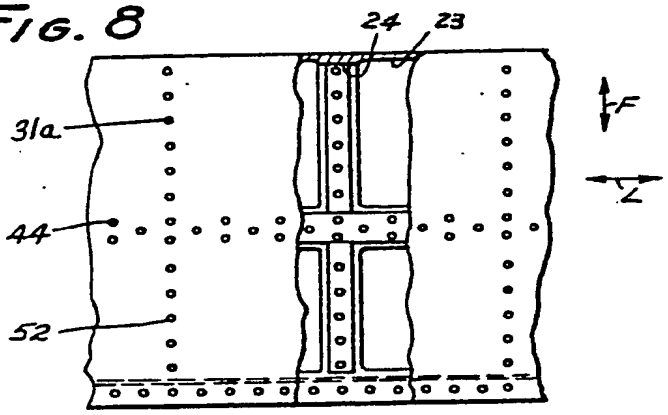

FIG. 6